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DARLUCA ON PERIDERMIUM PECKII*

J. F. Adams

(With Plate 21)

The genus *Darluca* in the family Sphaeropsidiaceae of the Fungi Imperfecti includes species which are reported on the leaves of deciduous plants as well as being parasitic on the Uredineae.

Darluca filum (Biv.) Cast. is a species most commonly mentioned as a frequent parasite on various species of Uredinales. Saccardo[15] states that it is uredinicolis and Sydow[18] and Grove[9] refer to it as a parasite growing on the uredo layer. Lindau[11] reports it as cosmopolitan on aecidia of various uredinia. Rostrup[14] lists it on *Chrysomyxa abietis* (2346). Cornu[7] says it attacks the telia of *Puccinia Prunorum* and *Puccinia Caricis.* Fuckel[8] finds it on urediniospores of various species and teliospores of *Uromyces Cytissi.* Tulasne[19] reports *Diplodia punctata* which corresponds to *Darluca filum* on *Uredo farinosa, U. falicis, U. Euphorbiae* and *U. Epilobii.* Broisi[3] has mentioned this parasite on *Puccinia bromia* and *Puccinia Triseti.*

McAlpine[12] finds it quite common for the uredo-layer to be attacked by this fungus and has found it upon 24 per cent of the species of *Puccinia.* "It occurs on aecidia, uredo and teleuto layers, and is recorded on *Uromyces, Uromycladium, Puccinia, Phragmidium* and in *Uredo.*

Cobb[6] unquestionably discusses this same parasite in connection with the peach rust (*Tranzschelia punctata*). He states "I frequently find among the Uredospores of a parasite of this rust small black pycnidia producing a multitude of two-celled spores, which when placed in a moist chamber often bud and multiply after the manner of yeast plants, but which occasionally produce a mycelium. Further, I find in the pustules of a number of Australian rusts similar tiny black pycnidia, producing similar two-celled spores which behave in precisely the same manner. Among other rusts producing these bodies is that occurring on Acacias, and that which occurs on a species of *Agropyron,* probably the species *scabrum.* There *a priori* two ways accounting for these pycnidia, either (1) they are parasites on the rust, or (2) they are an integral part of the rust, and represent another spore form of the rust." "These two-celled bodies have, as I have in several occasions publicly remarked, no slight resemblance to the so-called spermagonia of several species of *Aecidium* and this idea has already been fruitful of considerable discussion. Do not the various bodies that have in this connection been called spermagonia and spermatia need a more careful examination than they have yet received."

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Halsted[10] reports it on the uredo sorus of the asparagus rust and "in some localities this parasite upon the asparagus rust has been so abundant as to make it difficult to find a fully developed rust spot free from *Darluca.*" Sirrine[17] finds it spreads upon the uredo stage of the asparagus rust. "During past summer (1900) *Darluca* attacked the aecidial stage of the rust about June 10. We have even found sori in which the uredospores were apparently destroyed by *Darluca* while at the bottom of the sorus a layer of evidently healthy winter spores would be found." He is of the opinion "that *Darluca* attacks the spores of only the aecidial and uredo stages and does not injure the vegetative portions." Clinton[5] reports it on the aecia, uredinia and telia of the asparagus rust and occurring on the carnation and blue grass rust. Pammel and Hodson[13] consider it does much to prevent the ravages of the asparagus rust and report it common in 1900 on corn rust.

Darluca filum is frequently found on *Kueneola obtusa* in the eastern states. I have studied also material growing on *Coleosporium delicatulum* on *Euthamia tenuifolium* and on *Dicaeoma poculiforme* on *Phleum pratense.* Ellis and Everhart list *Darluca arcuata* on the andropogan rust which differs from *D. filum* by having three celled spores.

The parasite is easily recognized when found on the Uredinia and telia sori. It appears to overrun the sori after developing aggregate black pycnidia that appear as in a stroma. It apparently checks spore formation and distribution.

I have been unable to find in the literature where *Darluca filum* has been reported on any species of rusts attacking Gymnosperms. The writer collected material of *Peridermium Peckii* on *Tsuga canadensis* at Charter Oak, Center County, Pa., for study in the early stages of the development of the aecidium. The material was collected May 20, 1917 and at this time it was possible to find infected leaves with immature as well as sporulating aecia. The young infected leaves are easily recognized by their yellow appearance. At this time there was no evidence of *Darluca* growing on any of the rust infected leaves. The parasite was only recognized on examining sections through rust infected leaves of material collected in 1917.

During the spring of 1919 rust infected leaves of hemlock were carefully examined and in several instances mature aecia were found which were parasitized with *Darluca*. The black pycnidia could be recognized in the sori but not as conspicuous as found on other species of rust. The infection can be easily overlooked. Additional material was collected and fixed for further study.

On the leaves of hemlock, *Peridermium Peckii* forms two rows of conspicuous cylindrical aecia which are erumpent on the under surface. The pycnia develop subcuticularly and frequently were formed on the upper surface but more commonly on the under surface of the needle.

The mycelium of the rust is distributed throughout the leaf and the aecial primordia originate between the fibro vascular bundle and lateral resin duct. It has been observed that the aecia rupture at a stoma possibly because of least resistance. The mycelium of the parasite is similar in size to that of the rust but can be distinguished easily by the smaller nuclei, less cytoplasmic contents and sparsely septate mycelium.

Infection by *Darluca* may occur with the aecial primordia or mature aecia. When the primordia of the aecia are infected considerable disorganization of the rust mycelium occurs. The pycnidia of the parasite appear to suppress development by encroachment. The hyphae making up the aecial primordia do not show the normal nuclei or protoplasmic contents. These hyphae by their strong affinity for the stain and poor stainable contents indicate their disorganization. No further cytological evidence could be observed between the parasite and rust. The preparations were examined carefully for haustoria or other penetration of the rust mycelium by the parasite. Where mature aecia are infected the parasite appears to be concerned in suppressing spore distribution. The pycnidia develop in the aecial cup with the peridia still entact. Only a few mature spores are found below the pycnidium. The mycelium of the parasite ramifies throughout the spore mass and appears to engulf the spores. Several instances were found where the pycnia were parasitized upon the upper surface of leaves. Considerable disorganization of the pycnia were observed to follow such infection. I have been unable to find in the literature where this rust stage has been reported infected by *Darluca.*

My observations indicate that the resultant effect of the parasite is to prevent aecia maturing and suppress spore distribution. Owing to the deep origin of the aecia, the pycnidia of the parasite are submerged or endogenous and not easily recognized in contrast to its growth on other species of rusts. This sort of hidden relation between parasite and rust may be more common than heretofore supposed.

Sappin Trouffy[16] has studied *Darluca filum* on the uredinia of *Puccinia Porri.* He finds the mycelium ramifies throughout the sori and becomes attached to the urediniospores by "crampons." It is stated that the parasite assumes a "rôle destructeur." His illustration (Fig. 2) shows the mycelium of the parasite in the uredinia with apparent haustoria penetrating the sub-basal cells of the sori as well as the "crampons" attached to spores. He finds the parasite presents the same characters on *Puccinia graminis* and *Puccinia Menthae.* I have been unable to observe this situation in any of my preparations.

The original description of *Darluca* by Castagne[4] and that given by Saccardo[15] is different with respect to the morphology of the spores. I have not been able to determine the reason for the change from the original description by Saccardo.[15] The following discussion presents the facts so far as I am able to determine regarding the presence or absence of bristle spores.

Bivona described this parasite as *Sphaeria filum* (Tab. 3, f. 1, C. C. D. E.) but no mention is made of bristle spores. Castagne[4] established the genus *Darluca* making *Darluca vagans* (Cast. herb.) and *Sphaeria filum* Biv. synonyms and the fungus then became known as *Darluca filum* (Biv.) Cast. Castagne[4] makes no reference to the presence of bristle spores and that he took cognizance of the other synonyms is indicated in the following quotation. "Cette plante a d'abord été décrité par Bivona sous le nom de *Sphaeria filum,* M. Fries dans son Systema mycologicum, t. 2, p. 547, en fit son *Phoma filum,* puis dans l'Elenchus fungorum, t. 2, p. 119, il l'a rangée dans le genre *Septoria*; elle devint le *Septoria filum.* M. le Docteur Montagne est de la même opinion et la place dans la tribu des *Ascospora*; C'est pour lui le *Septoria* (*Ascospora*) *filum.* M. le Docteur Léveillé pense que c'est un Diplodia qu'on pourrait désigner sous le nom de *Diplodia punctata*; M. Desmazieres en fait un *Hendersonia* et il le décrit sous le nom d'*Hendersonia uredinaecola* (Ann. des. Sc. Nat., 3 serie, t. 11, p. 345), et un *Diplodia* dans les Plantes Crypt. de France, 1486, sous le nom de *Diplodia uredinaecola*; enfin M. Berkeley, que j'ai consulté sur cette controverse, pense qu'on doit en faire un *Sphaeronema.* La variété d'opinion des premiers cryptogamistes d'Europe a' ce sujet, m'engage á proposer la création d'une genre nouveau pour botanistes sous le nom de *Darluca vagans.* Le Nom de *Darluca* est un hommage rendu á la mémoire de Michel Darluc, docteur en medecine, mort en 1783, anteur d'une histoire naturelle de Provence."

No mention is made of bristle spores in *Hendersonia* (*Sphaerospora*) *uredineaecola* Desmaz. or *Diplodia* (*Hyalospora*) *uredineaecola* Desmaz. The descriptions as well as the illustrations of the spores in *Phoma Filum* Fr. and *Darluca vagans* Cast. are without bristles.

So far as I have been able to determine the first mention of bristle spores is in Saccardo's[15] description of *Darluca* Cast. where he states that the spores are "untrinque mucosa—vel. subpenicillata-apiculatae" and in *Darluca filum* (Biv.) Cast. he states the spores are described as "breve mucosa-penicillatis." However, in the case of *Darluca Sorghi* Zimm. no mention is made of bristle spores. Lindau[11] illustrates the spores with two or three bristles at each end.

Sappin-Trouffy[16] in his studies of this parasite has failed to observe the presence of bristle spores. Underwood[20] refers to the spores as similar to *Ascochyta* and *Actinonema* which are without bristle appendages. Blodgett[2] illustrated this parasite on the carnation rust but did not observe the presence of bristle spores.

I have failed to find the presence of bristles on young or mature spores of this parasite growing on the three species of rust I have studied. In this respect the form I have studied would agree with the original description of Castagne and Bivona. It is possible that another form appears similar to this species but with bristle spores, in which case it should be considered as a new species. A monograph of this genus undoubtedly would clear up the inconsistency with respect to the morphology of the spores. The bristles may be present only with young spores as indicated in the species *Darluca Bivonae* Fuckel as Allescher[1] reports the young spores possess bristle ends but absent with mature spores.

Saccardo[16] lists *Darluca Sorghi* Zimm. as a parasite on *Puccinia purpureae* without bristle spores. This species agrees with Castagne's original description as well as with the form I have studied.

The pycnidia vary somewhat in size on the three species of rust I have studied but agree with the measurements of other authors. Castagne says the spores vary from two to three celled but the three celled are rare. Slight variations in the spores are found but not so great as to designate them as separate species. I have found the spores uniformly two-celled. Saccardo gives the following measurements: *Darluca filum,* 3 to 4 x 15 to 18 μ; *Darluca Sorghi,* 4 to 13 x 16 μ. The following spore measurements I have taken from fresh material: *Darluca filum* (Biv.) Cast. on *Peridermium Peckii,* 3 to 4 x 13 to 19 μ; *Darluca filum* (Biv.) Cast. on *Coleosporium delicatulum,* 3 to 7 x 10 to 16 μ; *Darluca filum* (Biv.) Cast. on *Puccinia graminis,* 3 to 7 x 12 to 16 μ.

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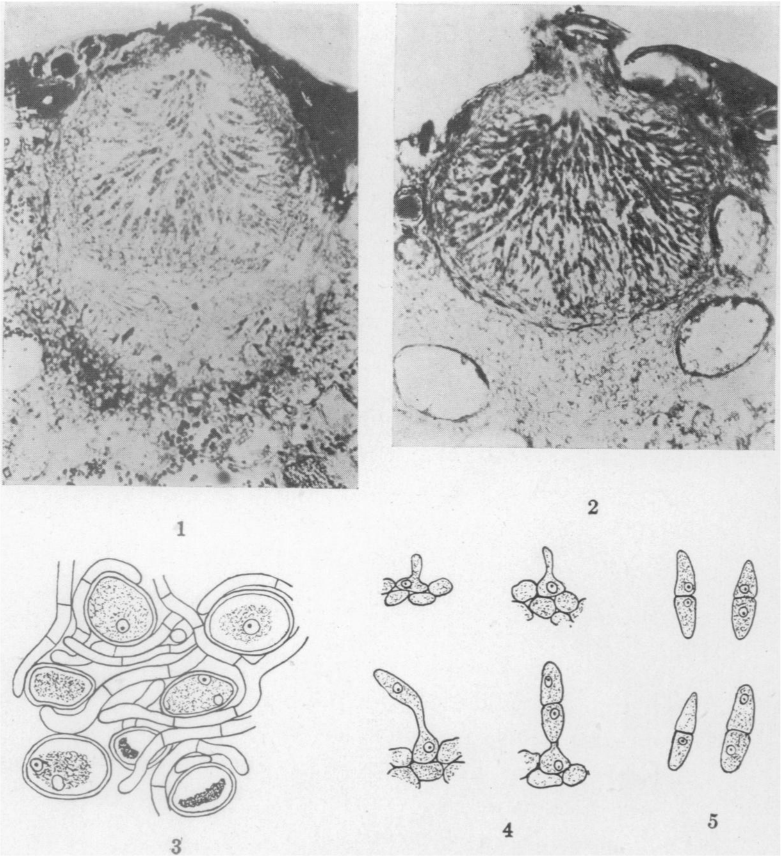

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EXPLANATION OF PLATE 21

Fig. 1. Photomicrograph of a cross section of the pycnidium of *Darluca filum* on the aecium of *Peridermium Peckii.* Just below the pycnidium the disorganized aecium is evident. The basal cells and sub-basal tissue is completely collapsed. Several aeciospores are evident below the pycnidium.

Fig. 2. Photomicrograph of a cross section of the pycnidium of *Darluca filum* on the primordium of the aecium of *Peridermium Peckii.* The primordium of the aecium is evident just below the pycnidium. The primordium is not disorganized but the cells have degenerated and show little protoplasmic contents. Early infection of a primordium prevents any further development.

Fig. 3. Mycelium of *Darluca filum* ramifying and engulfing the aeciospores in a mature aecium of *Peridermium Peckii.* Plasmolysis of the spores is associated with the establishment of *Darluca.*

Fig. 4. Various stages in spore development of *Darluca filum.*

Fig. 5. Typical two celled spores of *Darluca filum.*